# Introduction

CHAPTER 1

# *Voyages with the Master*

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When I arrived in Philadelphia in August of 1969, I knew only of John Meurig Thomas the scientist. For more than three decades since then I have had the privilege of knowing John the scientist, the friend, and the communicator. In each of these dimensions, John is a Master. And he has one more unparalleled fourth dimension – a brilliant memory and a mental hard disk with unlimited storage capacity! Very few scientists are as versatile as John in his cross-linking of different science disciplines, and as cultured as he is in other facets of life – even in sports he was, as a schoolboy, the walking-race champion of Wales, and was also a member of the University of Wales cricket team in 1955.

My first encounter with John was in June of 1970 at the Molecular Crystal Symposium organized by Robin Hochstrasser in Philadelphia at the Laboratory for Research on the Structure of Matter (LRSM). Among the stars present were Aleksander Davydov, Don McClure, Jan van der Waals, Hans Christoph Wolf, Wilse Robinson, and others. What John presented was his studies of dislocations in organic crystals and their vital role in determining optical and electrical properties. As a beginner, I was unaware of the totality of his impact in the field, but what impressed me most was his masterful presentation which he delivered with clarity, eloquence, and scholarly intellect. This memorable experience at the conference prompted me to squeeze myself in between the stars (Figure 1) in order to have a picture in the proximity of the world-renowned Davydov and to have a few words with John. Of course, at my level, the discussion was primarily about his enchantment with Egypt which he explored later in 1973 as a Visiting Professor at the American University in Cairo.

By the time of the eighth conference in the same series, organized in June of 1977 by Mostafa El Sayed (Figure 2), I was an invited speaker and went to Santa Barbara from Caltech, where I had been appointed as an Assistant

**Figure 1** The conference photo taken in June of 1970 on the steps of the Laboratory for Research on the Structure of Matter at the University of Pennsylvania, Philadelphia. A.S. Davydov is in the first row, second from the left. John Thomas and I are in the second row, seventh and third from the left, respectively. The organizer of the conference, Robin Hochstrasser, is the tallest in the back row, with a smile, next to Peter Rentzepis.

Professor. John was there, also as an invited speaker, and again he delivered a powerful presentation. To this day I can recall the way John presented his work and particularly the way he handled the Chair of his session. In a preemptive strike designed to secure more time for himself he said, "Mr. Chairman, I am *about* to finish," meaning he needed another five minutes or more! At this meeting I realized one of John's most impressive traits – his expansive thirst for knowledge and his resulting interest in broad areas of science in general and scientists in particular. This was certainly true in my case. At the conference, I spoke about the phenomena of "optical coherence" in molecular crystals and the new techniques for direct probing, in a talk titled, "Optical dephasing and radiationless transitions in molecular crystals." Instantly, John became interested and asked me numerous questions with a display of genuine excitement about the development, even though it was not his area of primary interest.

We did not cross paths again for some time, until a meeting at the Royal Society in London in February of 1990. In this discussion meeting, during which John presented his Bakerian lecture (on new crystalline catalysts), I gave a lecture titled "Femtosecond reaction dynamics," and John again was aware

**Figure 2** The conference photo taken in June of 1977 at a beachfront hotel in Santa Barbara, California. John Thomas and I are in the third row from the back (middle) and third row from the front to the right, respectively. The organizer, Mostafa El Sayed, is in the front row fifth from the left.

of the research in this area. Following the lecture, he invited me for lunch where he told me a story and made a prediction. The story relates to our 1987 publication with Marcos Dantus and Mark Rosker on the direct observation of the transition state with femtosecond time resolution. John discussed the paper with his students at the Royal Institution (RI) (in particular, Kenneth Harris) and described it to them as a historic landmark paper. The prediction was that the work was deserving of the Nobel Prize. John was serious and I trusted his sincerity. But what was so unique was that he actually read the paper and appreciated the value of a contribution that was far from his own field of endeavor. In fact, he zoomed in on the central concept of coherence in observing atomic motions; a difficult concept to grasp, even for some experts.

It was at this meeting that I earned an invitation from John, as Director of the RI, to give the Faraday Discourse, enticing me – typical of John! – by mentioning the names of previous speakers from Caltech such as Robert Millikan, George Ellery Hale, Linus Pauling, and Murray Gell-Mann. John and his beloved wife, Margaret, were truly gracious hosts at the RI. With John as Director, the Faraday Discourse on March 22, 1991 was an experience organized in the true tradition of the place and the history it had integrated over time. Even though I knew the former Director, George Porter, for many years,

this was my first time as an invited lecturer. In the Director's flat, Margaret arranged a lovely dinner in the company of David and Jill Buckingham, Sir Brian and Lady Pippard, Sir Geoffrey and Lady Wilkinson, and Lord and Lady Dainton (formerly Sir Fredrick Dainton). A few minutes before the lecture I was locked in a small room, literally a "Faraday cage." But just before caging me, John handed me a postcard of Sir James Dewar of liquid hydrogen fame on the back of which he had written the names of the three Nobelists from Caltech who had been in a similar situation, with John again making his obvious implication!

At exactly 9:00 p.m., John and I, in our tuxedos, walked together into the theatre as its double doors opened, and I began the lecture. The Discourse was held in the same place Michael Faraday lectured, and it surely radiated past achievements and displayed a sense of history, and John fitted in well among the previous Directors, Davy, Faraday, Bragg (Sir Lawrence), and Porter. Eadweard Muybridge gave a discourse on "animals in motion", on March 13, 1882, at which T. H. Huxley and the poet Alfred, Lord Tennyson were present. We found his discourse demonstration of a slotted drum which, upon rotation, shows the animated horse in motion. I had thought of relating my discourse to motion, but now to the motion of atoms, with the title, "Filming in a millionth of a billionth of a second." The theatre was packed and I thought of embarrassing John, but without success. I mentioned that the only way I could explain the full attendance was that the Director must have promised them a discourse by Omar Sharif. John led the audience with a big laugh!

Since that time, I have greatly enjoyed both my scientific and personal interactions with John. I have become increasingly aware of his extraordinary ability to look at the big picture of science and humanity and in his genuine interest in popularizing science. His book on Faraday and his writings on Humphry Davy, Lawrence Bragg, and Max Perutz are examples of his devotion to the service of knowledge and his brilliant mastery of the English language – with a strong, attractive Welsh accent! In fact, I have two bulky files loaded with John's outside-of-science writings. But, John is also a caring fellow scientist. He has written many obituaries and given the eulogies of distinguished scientists to salute their contributions to science and society. I have repeatedly told John to write my obituary in advance as I know it will be exceptional! He is also a cultured man in music, art, and history. John does all of these activities while maintaining passionate interest in his own science with pioneering contributions over six decades of research at the University of Wales, in Bangor and Aberystwyth, University of Cambridge, and the RI.

John is distinguished for his innovative and diverse contributions, from solid state chemistry to heterogeneous catalysis, including the study of nanostructures, long before they became popular! He and his co-workers have designed, synthesized, and characterized hundreds of new heterogeneous catalysts. He has also developed and applied a wide range of tools for the study of solids and their surfaces, zeolites, clays, and other analogs. With these techniques, he has elucidated the importance of the structure in the function. The methods involved include high-resolution electron microscopy, electron diffraction,

synchrotron radiation, solid-state NMR, photoelectron spectroscopy, and computational techniques. At present, with Paul Midgley and others, he is pioneering powerful *ex situ* techniques, such as nanotomography and nanoholography, for studying solids. Moreover, he has established *in situ* methods for investigating solid catalysts, the result of which, through his ''single-site'' solid catalysts, provide strategies that are applicable in the design of new catalysts for a wide range of reactions. Earlier, John was a leader in elucidating the manner in which the surface and bulk properties of crystals are influenced by structural imperfections, notably dislocations. This work on dislocations was critical to the understanding of physical, chemical, and spectral properties of crystals such as graphite, layered minerals, and molecular solids.

His interest in diffraction and microscopy turned out to be the first scientific bonding we had. In 1991, the same year I gave the Faraday Discourse, I proposed ultrafast diffraction as a method for structural dynamics. Without delay, in the same year, John wrote a ''News and Views'' piece in *Nature*[1] titled ''Femtosecond diffraction.'' Towards the end of the piece, he concluded with the following words: ''If the experiment does indeed prove successful, it will mark the dawn of an important new era ...'' It took one decade (2001), and developments over several generations of instruments, to transform a dream into reality, from the exploration of the potential of the approach to the explosion of the applications in real experimental determination of isolated transient molecular structures.

In retrospect, what is remarkable about John is his broader vision of the significance of determining structures in the act of change irrespective of the phase they are in. When we reached the condensed phase with ultrafast electron crystallography in 2004, John published in *Angewandte Chemie*[2] an overview pointing out several potential applications including those in heterogeneous catalysis. But, he reached the apex of excitement when it became possible to image in real space with 4D ultrafast electron microscopy using single-electron packets. Because John has followed the trajectory of developments since its naissance, and is himself a pioneer in the applications of microscopy to materials science, he decided to write a 2005 highlight in *Angewandte Chemie*[3] describing the development and the prospects for numerous branching applications. In the same year, 2005, Kenneth Harris and John in a paper published in *Crystal Growth and Design*[4] explored some applications in domains of biological macromolecules and solid-state chemistry. Once again his passion for a new development was sincere and scholarly.

After Margaret passed away, John needed his friends as much as ever, especially with the vacuum left behind by Margaret after decades of being together and sharing wonderful events at the RI, Peterhouse, and places all over the globe. And so I was delighted to see him in Cairo on the occasion of his receiving an honorary degree from the American University in Cairo in 2002, and we spent some time reflecting on life and science. To me, time spent with John is never dull, and is always enriching to the intellect and spirit. This tradition of intense and pleasurable discussion continues until today with visits in Cambridge, Pasadena, and other places around the world. The last time

**Figure 3** A recent photo taken in June of 2006 at the University of Cambridge on the occasion of an Honorary Degree celebration to the Archbishop of Canterbury, The Most Rev. and Rt. Hon. Dr. Rowan Williams (in Divinity) and the author (in Science). John Thomas joined us in the celebration as a member of the faculty dressed in his colorful Scarlet Festal Robe. The Archbishop was born in Swansea into a Welsh-speaking family, making this photo indeed special, as I am surrounded by Wales' most distinguished men of faith and of science.

I was in Cambridge in the summer of 2006 (Figure 3), we went on a walk and John showed me the hospital where Margaret passed away and the walks that they took together. And that is what life is about, especially when recognizing our fate as noted by Shakespeare's Prospero: "We are such stuff as dreams are made on, and our little life is rounded with a sleep." In Margaret's eulogy in October of 2002, John closed with the words, "She left the world a better place."

In life one meets many people, interacts with some for the sake of mutual benefits, dislikes some for their attitude or personality, but cherishes only a special few for their integrity, professional achievement, and human decency. John is just such a person. Despite his attributes of great value and character, I dislike one thing about John. In his presence one feels a brain memory capacity of kilobytes while his is gigabytes or more. He recalls with lucidity events, names, and stories from long ago as if they happened yesterday, while the rest of us struggle to remember. At a recent meeting of the American Philosophical Society, I asked our mutual friend Jack Roberts, "Has John been consistent in

his story telling over the years?'' Jack answered, ''The trouble is that I do not know because I forget most of the stories!''

John, you are truly a master of science and humanity. We all wish you a very happy 75th birthday and we expect to celebrate your 100th remembering, John, that Ramses II lived to be almost 100, and you do not yet have even close to his 110 children!

## References

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